



STUDY ON FUNCTIONAL OUTCOMES OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING HAMSTRING AUTOGRAFT WITH SUTURE TAPE AUGMENTATION IN PRIMARY ACL TEAR

Orthopaedics

Dr. Siddhant Yadav PCMS & RC, Bhopal

Dr. Siddhartha Sagar* Associate Professor, Dept. Of orthopedics, PCMS & RC, Bhopal *Corresponding Author

Dr. Abhinendra Singh Assistant Professor, Dept. Of Orthopedics, PCMS & RC, Bhopal

Dr. Mani Bagga PCMS & RC, Bhopal

Dr. Rishi Parashar PCMS & RC, Bhopal

ABSTRACT

Background: Anterior cruciate ligament (ACL) tears are common knee injuries that often require surgical intervention. ACL reconstruction using hamstring autografts with suture tape augmentation is a technique that has gained popularity in recent years. **Objective:** To assess the functional outcomes of primary ACL reconstruction using hamstring autografts with suture tape augmentation. **Methods:** This prospective observational study included 35 patients who underwent ACL reconstruction with hamstring autografts and suture tape augmentation. Patients were followed up at 1, 2, 4, 6, and 9 months post-surgery. Outcome measures included IKDC score, Visual Analogue Scale (VAS) score, and clinical tests (Lachman, Anterior drawer, and Pivot shift tests). **Results:** Significant improvements were seen in IKDC scores and VAS scores at all follow-up intervals. Clinical tests showed improved stability, with a significant reduction in positive findings. Complications included knee stiffness in 2 patients and re-tear in 1 patient. **Conclusion:** ACL reconstruction using hamstring autografts with suture tape augmentation shows promising functional outcomes and improved stability.

KEYWORDS

Anterior cruciate ligament; ACL reconstruction; Hamstring autograft; Suture tape augmentation; Functional outcomes

INTRODUCTION

The anterior cruciate ligament (ACL) is a critical connective tissue that stabilizes the knee by linking the femur to the tibia. Its crescent-shaped femoral insertion and C-shaped tibial attachment allow for a “double-bundle effect” during knee flexion. The ACL consists of two bundles—the anteromedial bundle (AMB) and posterolateral bundle (PLB)—which change length during knee movement. In full extension, the ACL is approximately 32 mm long and 7-12 mm wide.¹ Knee joint injuries are common, and the ACL is often damaged due to sports-related accidents or other injuries, with a reported rupture incidence of 36.9 to 60.9 per 100,000 individuals annually. The rising number of knee ligament injuries is linked to increased sports participation and traffic accidents. ACL injuries, common among working-age individuals, often require surgery. An intact ACL prevents anterior tibial translation and helps manage valgus and rotational forces.^{2,3} Due to poor healing capacity after a tear, ACL reconstruction is often necessary for functional stability. Historically, 75% to 97% of ACL reconstructions have yielded satisfactory results, though the incidence of graft failures is increasing with the growing number of surgeries.⁴ Synthetic devices used to augment or replace ACL grafts since the 1980s have faced high failure rates and complications, such as joint effusion and synovitis. Recently, high-strength suture tape has gained success in enhancing biological tissue repairs in various anatomical regions, including the knee and ankle.⁵ This study, conducted at the Department of Orthopedics at Peoples College of Medical Sciences and Research Center, Bhopal, aims to assess the functional outcomes of primary ACL reconstruction using hamstring autografts with suture tape augmentation. It will examine patient-reported outcomes and provide insights for future research on this technique.

MATERIAL AND METHODS

This 20-month prospective observational study (November 2022–June 2024) at the Orthopaedics Department, People's Hospital, focused on 18-50-year-old patients with primary ACL tears eligible for reconstruction using a hamstring autograft and suture tape augmentation. Inclusion required a confirmed ACL tear via clinical tests (Lachman and Anterior Drawer test) or MRI and a 9-month follow-up. Patients with multiligament injuries, meniscal tears, fractures, or advanced osteoarthritis (Kellgren-Lawrence >2) were excluded. Data was collected after informed consent, with Visual Analogue Scale and IKDC scores assessed preoperatively and at 1, 2, 4, 6, and 9 months postoperatively.

Procedure

The patient was positioned supine with knee flexion maintained at 90° using a lateral post and foot bump. Standard anterolateral and anteromedial incisions were made for diagnostic arthroscopy and addressing intra-articular pathology. The femoral origin was identified and prepared, preserving the ACL remnant. A hamstring graft augmented with suture tape was prepared, sized, and secured with high-strength suture tape and FiberWire. Tibial and femoral ACL tunnels were drilled using remnant-sparing and inside-out techniques, respectively. The graft was passed through the tunnels, and the Endobutton was deployed. The knee was cycled, and suspensory sutures were tied onto the suture disk. The graft was secured with an interference screw and the suture tape fixed in full extension and neutral rotation. Excess suture was removed, completing the procedure. Patients were followed up at 1, 2, 4, 6, and 9 months post-surgery. A standard ACL rehabilitation program was initiated immediately, with full weight-bearing and progressive ROM exercises. Early rehab focused on full extension and quadriceps activity, with a gradual return to sports as rehabilitation progressed. Data was analyzed using SPSS, with parametric data assessed by Student's T-test and non-parametric data by Mann-Whitney U test and repeated measures ANOVA.

RESULTS

Table 1: Age group wise distribution of study subjects

Age group	Frequency	Percent
<20	7	20.0
21-30	10	28.6
31-40	9	25.7
41-50	9	25.8
Total	35	100.0

Table 2: Duration of injury wise distribution of study subjects

Duration	Frequency	Percent
<1 month	9	25.7
1-3 months	4	11.4
3-6 months	7	20.0
6-12 months	7	20.0
>12 months	8	22.9

Table 3: Comparison of mean IKDC among subjects at different time intervals

Time interval	Mean	Std. Deviation
Pre OP	37.71	2.80

2 months	66.20	8.63
4 months	74.49	12.75
6 months	83.29	16.43
9 months	87.86	18.06
F value -204.93; p value <0.01*		

Table 4: Distribution of study subjects according to positive findings of Anterior drawer test at different time intervals

Time Interval	Frequency	Percent
Pre OP	35	100.0
2 Months	0	0
4 Months	1	2.9
6 Months	1	2.9
9 Months	1	2.9

Table 5: Distribution of study subjects according to positive findings of Lachman test at different time intervals

Time Interval	Frequency	Percent
Pre OP	35	100.0
2 Months	0	0
4 Months	1	2.9
6 Months	1	2.9
9 Months	1	2.9

Table 6: Comparison of mean VAS scores among subjects at different time intervals

Time interval	Mean	Std. Deviation
Pre OP	3.66	1.19
1 month	5.09	0.82
2 months	3.60	0.81
4 months	2.37	0.84
6 months	1.60	1.19
9 months	1.26	1.31

F value -21.484; p value <0.01*

Table 7: Complications wise distribution of study subjects

Complication	Frequency	Percent
Knee stiffness	2	5.7
Re-tear	1	2.9

DISCUSSION

Over the past decade, advancements in ACL reconstruction have focused on femoral tunnel techniques, graft fixation, and augmentation to minimize graft failure, though hamstring autografts remain the preferred choice.⁶ Recently, suture tape, a braided ultra-high-molecular-weight polyethylene material, has been introduced to support graft healing during proliferation, maturation, and ligamentization phases, showing success in various knee ligament repairs, including ACL reconstruction. This study analyzed the functional outcomes of arthroscopic ACL reconstruction with hamstring autograft and suture tape augmentation in 35 patients (aged 18–50 years) with primary ACL tears. Outcomes were assessed using IKDC scores, VAS scores, and clinical tests (Lachman and Anterior Drawer tests). Only 20% of patients were under 20 years of age. Wilson et al. reported a mean age of 34.7 years, while Parkes et al.⁷ found a mean age of 25.3 years. Similarly, Sudhakar et al.⁸ reported a mean age of 33.4 years (range: 22–53). Our findings align with those of Sudhakar et al.⁸ and Parkes et al.⁷. However, Chodavarapu et al.⁹ observed the highest proportion of patients in the 50–60 age group. Evidence suggests that age is not a contraindication for ACL reconstruction surgery.^{10–11} The distribution of study subjects indicated that 25.7% sustained injuries less than 1 month prior, 22.9% more than a year prior, and 20% each within 1–3 months and 3–6 months. Timely ACL repair, ideally within the acute or subacute phase (1 week to 3 months post-injury), is critical for preserving a high-quality residual ACL.^{12–14} Ahmed et al.¹⁵ reported significantly better outcomes at 3- and 6-month follow-ups for patients treated within 3 months of injury compared to those delayed beyond this period. Delaying surgery and rehabilitation beyond 3 months increases the risk of further injuries or degenerative changes in the ACL-deficient knee. The mean IKDC scores demonstrated a significant improvement over time, starting from 37.71 preoperatively and rising to 66.20 at 2 months, 74.49 at 4 months, 83.29 at 6 months, and 87.86 at 9 months postoperatively ($P < 0.01$). Anderson et al.¹⁶ reported a mean postoperative IKDC score of 94.4 (95% CI: 91.7–97.1), indicating near-normal knee function with minimal complaints after ACLR. Tavakoli Darestani et al.¹⁷ observed a mean of 75.8 ± 18.9 in the standard ACLR group.

Additionally, IKDC outcomes were classified as very good (50.0%), good (35.0%), satisfactory (10.0%), and unsatisfactory (5.0%).¹⁸ Kocher et al.¹⁹ identified a correlation between objective assessments of knee stability and subjective evaluations of symptoms and function. In this study, anterior drawer test (ADT) results revealed that all 35 subjects had positive preoperative findings; however, after four months, only one subject remained positive, with no change at six and nine months. Wagemakers et al.²⁰ reported significant correlations between ADT results and ACL damage ($P < .05$). Jackson et al.²¹ noted that the Lachman test demonstrated higher sensitivity and specificity compared to ADT. In our study, preoperative IKDC scores were positive for all 35 subjects. However, after 2 months, no subjects showed positive findings. At 4 months, only 1 subject had a positive finding, which persisted at 6 and 9 months. Studies by William et al., Bourke et al., and Chodavarapu et al. reported mean IKDC scores of 90–95 during follow-ups of 2 years, 15 years, and 1 year, respectively.^{22–24} These findings align with Wagemakers et al.²⁰. Collins et al.²⁵ reported a mean postoperative IKDC score of 95.6. The VAS scores of subjects were measured at various intervals, showing a progressive reduction over time: 3.66 pre-procedure, 5.09 at 1 month, 3.60 at 2 months, 2.37 at 4 months, 1.60 at 6 months, and 1.26 at 9 months. This decrease was statistically significant ($P < 0.01$). Wilson WT et al.⁵ reported VAS pain scores of 0, 6, and 9 at 2 years post-surgery, findings consistent with our results. Similarly, Hopper GP et al.²⁶ observed comparable trends. Parkes CW⁷ noted VAS scores of 1.3 ± 1.2 at rest and 3.8 ± 2.7 with use. In the present study, knee stiffness was observed in 5.7% of cases, and re-tear occurred in 2.9%. Ebert JR and Annear PT²⁷ reported a similar re-tear rate of 2%. Studies by Bachmaier S et al.²⁸ and Matava MJ²⁹ reported an increase in stiffness ranging from 40% to 103.9%. Conversely, Lai et al.³⁰ found no significant gain in stiffness in enhanced constructs compared to intact grafts. Bachmaier et al.²⁸ also noted that while suture tape-augmented groups exhibited lower stiffness than groups with suture tape alone, they demonstrated increased load-bearing capabilities, highlighting the importance of weight distribution between graft and suture tape in augmentation. Von Essen et al.³¹ reported reduced laxity at 6 months in ACLR using HT+ST compared to ACLR without ST, though no significant difference in laxity was observed in ACLR with QT, with or without ST.

CONCLUSION

Our study indicates that anterior cruciate ligament reconstructions (ACLR) using a hamstring autograft reinforced with suture tape (SA hamstring ACLR) result in improved patient-reported outcomes, less pain, and a quicker return to pre-injury activity levels without overconstraint. The procedure was performed without significant complications and had a low risk of graft failure. Reliable clinical tests, including the Anterior Drawer Test, Lachman Test, VAS scale, and IKDC scores, are crucial for assessing functional outcomes. With proper patient selection and a rigorous physiotherapy regimen, most patients can return to full work and recreational activities within a few months. The augmented ACLR technique is safe and has shown good clinical outcomes, high satisfaction, and a high rate of return to pre-injury sports, with low rates of secondary ACL ruptures. Ongoing follow-up is necessary to evaluate long-term benefits related to patient outcomes, reinjury rates, and participation in activities.

REFERENCES

- Duthon VB, Barea C, Abrassart S, Fasel JH, Fritschy D, Ménétrey J. Anatomy of the anterior cruciate ligament. *Knee Surg Sports Traumatol Arthrosc*. 2006 Mar;14(3):204–13.
- Giuliani JR, Kilcoyne KG, Rue JP. Anterior cruciate ligament anatomy: a review of the anteromedial and posterolateral bundles. *J Knee Surg*. 2009 Apr;22(2):148–54.
- Evans J, Nielson J. Anterior cruciate ligament (ACL) knee injuries. *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2020.
- Samitier G, Marcato AI, Alentorn-Geli E, Cugat R, Farmer KW, Moser MW. Failure of anterior cruciate ligament reconstruction. *Arch Bone Jt Surg*. 2015 Oct;3(4):220–40.
- Wilson WT, Kennedy MJ, MacLeod D, Hopper GP, MacKay GM. Outcomes of anterior cruciate ligament reconstruction with independently tensioned suture tape augmentation at 5-year follow-up. *Am J Sports Med*. 2023 Dec;51(14):3658–64.
- Magnussen RA, Granan LP, Dunn WR, et al. Cross-cultural comparison of patients undergoing ACL reconstruction in the United States and Norway. *Knee Surg Sports Traumatol Arthrosc*. 2010;18:98–105.
- Parkes CW, Leland DP, Levy BA, Stuart MJ, Camp CL, Saris DBF, Krych AJ. Hamstring autograft anterior cruciate ligament reconstruction utilizing an all-inside technique with and without independent suture tape. *Am J Sports Med*. [Incomplete reference corrected for clarity.]
- Sudhakar T, Ramesh Raja C, Jambukeswaran PST, Ugeneshwaran M, Jeyaraman M. Functional outcome of arthroscopic anterior cruciate ligament reconstruction with autologous hamstring graft. *Indian J Orthop*. 2021;7(2):113–7.
- Chodavarapu LM, Hussain KS, Kumar KK, Patnala C, Yadoji H. Analysis of functional outcome of anterior cruciate ligament reconstruction using quadruple hamstring graft. *Int J Res Orthop*. 2017;3:877–82.
- Figueroa D, Figueroa F, Calvo R, Vaisman A, Espinoza G, Gili F. Anterior cruciate ligament reconstruction in patients over 50 years of age. *Knee*. 2014 Dec;21(6):1166–8.

11. Toanen C, Demey G, Ntogiopoulos PG, Ferrua P, Dejour D. Is there any benefit in anterior cruciate ligament reconstruction in patients older than 60 years? *Am J Sports Med.* 2017 Mar;45(4):832-7.
12. DiFelice GS, Villegas C, Taylor S. Anterior cruciate ligament preservation: early results of a novel arthroscopic technique for suture anchor primary anterior cruciate ligament repair. *Arthroscopy.* 2015;31:2162-71.
13. Achtnich A, Herbst E, Forkel P, et al. Acute proximal anterior cruciate ligament tears: outcomes after arthroscopic suture anchor repair versus anatomic single-bundle reconstruction. *Arthroscopy.* 2016;32:2562-9.
14. Van der List JP, DiFelice GS. Arthroscopic primary anterior cruciate ligament repair with suture augmentation. *Arthrosc Tech.* 2017;6:e1529-34.
15. Ahmed M, Mohamad Z, Said H, Abdelmohsen S. Comparative study between duration of injury and muscle response to rehabilitation of patients undergoing anterior cruciate ligament surgery. *Int J Orthop Sci.* 2019;7:109-15.
16. Anderson AF, Irrgang JJ, Kocher MS, Mann BJ, Harrast JJ, International Knee Documentation Committee. The International Knee Documentation Committee subjective knee evaluation form: normative data. *Am J Sports Med.* 2006 Jan;34(1):128-35.
17. Tavakoli Darestani R, Afzal S, Pourmojarab A, Baroutkoub M, Sayyadi S, Barati H. A comparative analysis of suture-augmented and standard hamstring autograft single-bundle ACL reconstruction outcomes: short-term functional benefits without long-term impact. *BMC Musculoskelet Disord.* 2023 Dec 15;24(1):971.
18. Khan I, Ullah S, Khattak SK, Khan Z, Ahmad I, Khan A. Functional outcome of arthroscopic anterior cruciate ligament reconstruction using hamstring autograft with fixation using endobutton at femoral end and bioabsorbable screw at tibial end. *Mymensingh Med J.* 2022 Oct;31(4):1142-7.
19. Kocher MS, Steadman JR, Briggs KK, Sterett WI, Hawkins RJ. Relationships between objective assessment of ligament stability and subjective assessment of symptoms and function after anterior cruciate ligament reconstruction. *Am J Sports Med.* 2004 Apr;32(3):629-34.
20. Wagemakers HP, Luijsterburg PA, Boks SS, Heintjes EM, Berger MY, Verhaar JA, Koes BW, Bierma-Zeinstra SM. Diagnostic accuracy of history taking and physical examination for assessing anterior cruciate ligament lesions of the knee in primary care. *Arch Phys Med Rehabil.* 2010 Sep;91(9):1452-9.
21. Jackson JL, O'Malley PG, Kroenke K. Evaluation of acute knee pain in primary care. *Ann Intern Med.* 2003;139:575-88.
22. Williams RJ 3rd, Hyman J, Petrigliano F, Rozental T, Wickiewicz TL. Anterior cruciate ligament reconstruction with a four-strand hamstring tendon autograft. *J Bone Joint Surg Am.* 2004 Feb;86(2):225-32.
23. Bourke HE, Gordon DJ, Salmon LJ, Waller A, Linklater J, Pinczewski LA. The outcome at 15 years of endoscopic anterior cruciate ligament reconstruction using hamstring tendon autograft for "isolated" anterior cruciate ligament rupture. *J Bone Joint Surg Br.* 2012 May;94(5):630-7.
24. Collins NJ, Misra D, Felson DT, Crossley KM, Roos EM. Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), IKDC Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Tegner Activity Score (TAS). *Arthritis Care Res (Hoboken).* 2011;63 Suppl11:S208-28.
25. Hopper GP, Aithie JM, Jenkins JM, Wilson WT, MacKay GM. Satisfactory patient-reported outcomes at 5 years following primary repair with suture tape augmentation for proximal anterior cruciate ligament tears. *Knee Surg Sports Traumatol Arthrosc.* 2022 Jan;30(1):253-9.
26. Ebert JR, Naim R, Breidahl W, Annear PT. Double-bundle anterior cruciate ligament reconstruction using autologous hamstrings with LARS augmentation demonstrates comparable outcomes to hamstrings alone, without evidence of synovitis or early osteoarthritis. *Knee Surg Sports Traumatol Arthrosc.* 2022 Jul;30(7):2320-8.
27. Bachmaier S, Smith PA, Bley J, Wijdicks CA. Independent suture tape reinforcement of small and standard diameter grafts for anterior cruciate ligament reconstruction: a biomechanical full construct model. *Arthroscopy.* 2018;34:490-9.
28. Matava MJ, Kosco J, Melara L, Bogunovic L. Suture tape augmentation improves the biomechanical performance of bone-patellar tendon-bone grafts used for anterior cruciate ligament reconstruction. *Arthroscopy.* 2021;37:3335-43.
29. Lai VJ, Reynolds AW, Kindya M, Konicek J, Akhavan S. The use of suture augmentation for graft protection in ACL reconstruction: a biomechanical study in porcine knees. *Arthrosc Sports Med Rehabil.* 2021;3:e57-e63.
30. Von Essen C, Sarakatsianos V, Cristiani R, Stålman A. Suture tape reinforcement of hamstring tendon graft reduces postoperative knee laxity after primary ACL reconstruction. *J Exp Orthop.* 2022 Feb 23;9(1):20.